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OF THE

Society for the Promotion of Engineering Education

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TABLE OF CONTENTS.

PAGE.

Editorials 2
Dean Anthony's Tour 2
Details of Technical English 2
Educational Economics 4
Hydraulic and Other Engineering Education 3
Grading Students 3
Echoes of the Discussion on Theses 4
Our Growing Membership 4
President Anthony's October Tour 5
Report on Mechanical Laboratory Instruction 7
Council Actions 10
Applicants for Membership 11
Notices 13
Other Societies 15
Letter to the Editor 1
Obituary Notices, Prof. A. J. Frith, Prof. Warren Babcock..... 17
Question and Kinks 19
College News 21
On Engineering English, by Prof. J. M. Telleen 29
The Cost of Educating a Student, by Dean C. H. Benjamin..... 34

PROCEEDINGS.

CIVIL ENGINEERING THESES, by Prof. C. E. SHERMAN 169
THE GRADING SYSTEM OF THE UNIVERSITY OF MISSOURI, by Prof. A. L. HYDE 173
Discussion 181
HYDRAULIC ENGINEERING EDUCATION, by Prof. D. . MEAD..... 185

EDITORIALS.

Dean Anthony's Tour. There was a time when the presidency of the Society involved comparatively little work; now its activities are so numerous and diversified that the president must spend much time and thought in meeting the responsibilities of his position. On account of his absence from the Minneapolis meeting Dean Anthony felt obliged to visit a number of centers of society interest to secure the suggestions of experienced members. This tour, taken partly as a matter of necessity, demonstrated the value of personal contact of the officers and groups of local members and will, it is hoped, form a valuable precedent. President Anthony now knows how all of the routine and publishing work is conducted, he has discussed convention details with the local authorities on the ground, he has been encouraged and assisted by the evidence of appreciation of the Society's work in several quarters and he has obtained a working grasp of the field of opportunity ahead. In return he has brought the Society closer to these communities.

Details of Technical English. It is encouraging to recognize the increasing burden of responsibitity being laid upon the Society by engineers and teachers. Some years ago the subject was mathematics and the result has been a large accession of mathematicians to the membership and real progress in co-operation between teachers of technology and teachers of mathematics. Now the Society is looked to for assistance in promulgating the gospel of clear English. Mr. D. M. Wright, a manufacturer and not a member, asks that nomenclature be standardized. In this issue Professor Telleen suggests even a larger field of activity, namely, that a central board be established to act as a clearing-house for all matters relating to usage in composition and definition. Judging from the standing of the findings of a number of committees of the Society such a board could exert great influence. The present committee on technical nomenclature can make a start in this direc-

tion. The work must deal with details, as well as general principles. It will be worth while even if a comparatively small number of terms are accurately defined.

Educational Economics. There are at least two reasons for studying the cost of educating students. In the first place the student should understand that he is not paying in the form of tuition fees more than a part of the cost of the tuition. On the other hand it is well for the teaching corps in a department of instruction to compare the cost of instruction per student-hour given by them with that given by other departments in their own and other lines. High cost will call for explanation and justification, low cost may impress administrative officers with the need for an enlarged corps. Of course there can be no standard cost, as so many variables enter into its make-up and there are so many ideas as to what constitutes a satisfactory education for a boy. The principle of efficiency, however, demands that the expenditure be commensurate with the result produced.

Hydraulic and Other Engineering Education. Professor Mead's Minneapolis paper deals, of course, with the specialty described in its title, but what impresses the reader most is the writer's characterization of engineering education in general. The hydraulic engineer, like every other engineer, must have learned to look upon each task as a problem. For the successful solution of such there are certain definite lines of procedure. An engineering problem cannot be correctly solved without correct fundamental data any more than can an algebraic, a physical or an economic problem. Whether or not hydrology should be included in a hydraulic engineering curriculum is, to the specialist, a detail of some importance, but from the general educational point of view it is much more important *how* this or any other subject is taught, than whether or not it is taught at all.

Grading Students. The bane of the teacher's existence is the necessity for grading his students and that of the student, the operation of being graded. As Professor Hyde points out

in the paper printed in this issue of the BULLETIN, grading is a necessary evil. The application of science to the subject is comparatively new and the University of Missouri deserves great credit for taking the lead in so applying it. The five years' experience in the use of the present system there has demonstrated particularly the beneficial effect upon the teachers. In this matter of grading, as in others humorously cited by Dean Goss in his recent paper on staff supervision, each teacher has been more or less a law unto himself. Scientific grading does away with this and the necessity for co-operation is no small part of the resulting benefit.

Echoes of the Discussion on Theses. Last month we printed Professor Hibbard's paper on thesis work which brought up for discussion a topic which has agitated the minds of teachers and students for generations. This society can do much to clarify the situation and to restore the thesis to its rightful place in the curriculum. With all of the intelligence and labor lavished on courses of study there are still many inconsistencies in them. These need only be pointed out to be remedied. Thesis work as oftentimes conducted belonged in this class. The former waste of time on the so-called thesis led to its being made elective in some quarters, in other words to its practical abolishment. There now seems to be a tendency to give systematic oversight to thesis work and to limit its scope within reasonable boundaries.

Our Growing Membership. A department store in Cleveland, Ohio, uses the advertising slogan 'watch us grow.' Growth is a sign of health and it is so in a society as well as in a department store. One of our prominent members, however, in a recent letter warns us against the prevalent megalomania with which so many organizations are affected and which seems to him a disease that can do no good. There is, of course, no use in growing just to see ourselves grow, but there are many excellent reasons for rapid growth of this society at this time. It is like the growth of telephone service, the larger the list of subscribers the more persons there are to

talk to and the more there are to talk. In our society the larger the membership the more there are to be benefited by its activities and the more there are to produce them. The evidences of aggressive life on the part of the Society are signs of healthy growth. Some of the new members are among the most effective contributors to it. These remarks are *apropos* of the encouraging new-membership campaign in which so many members are actively participating.

PRESIDENT ANTHONY'S OCTOBER TOUR.

The unwritten rule of the S. P. E. E. that the president-elect must be present at the convention which elects him may now be regarded as well proven by its two successive exceptions. In the case of President Magruder it may easily be accounted for, in that he is a charter member, a past secretary, a member of the council, a frequent contributor to its proceedings and always in touch with the latest throb of its development. The present incumbent found himself quite differently situated, and feeling the need of a more intimate knowledge of the administrative details of the Society, and having a desire to get into closer touch with those actively engaged in promoting its welfare, he decided to make a short tour for this purpose, believing that the good results accruing to the Society from such a tour would justify the expenditure of time on the part of the institution with which he is connected, and which is honored by the presidency. If one may judge from first impressions, the results are very gratifying.

The work of the Secretary has increased so rapidly since the publication of the BULLETIN was begun that a knowledge of the working details of the Society would seem to be of first importance to efficient service on the part of the President. Therefore, the tour was planned to begin and end with the Secretary, first at a conference in New York City, and lastly at Ithaca. At New York the plans for the Princeton meeting were considered at length and the recommendations of the

council provided for. At the same time, Mr. Charles H. Higgins, Secretary of the Princeton Engineering Association, brought a cordial invitation from President Hibben for the President of the S. P. E. E. to visit Princeton and consider details of the proposed convention. On the following day a foretaste of the hospitality to be extended the Society was experienced when Deans Magie and Fine set forth the attractive conditions which prevail at Princeton, and this was confirmed later in a conference with President Hibben. As it is proposed to publish the arrangements for this meeting as soon as definite plans can be formulated, and since we expect contributions descriptive of the historical, scientific and scenic attractions of Princeton, we need only assure the members at this time of the wisdom shown by the council in the early choice of Princeton for the convention of 1914.

The next stop made was at Pittsburgh where a joint meeting was held of the members from the University of Pittsburgh and the Carnegie Institute of Technology. At a dinner given at the Hotel Schenley some of the proposed plans for the Princeton meeting were made known and this was followed by a free discussion of the work of the Society which was suggestive of more profitable and interesting meetings, and was accompanied by much constructive criticism.

The necessity for meeting an appointment with Professor Magruder at Columbus shortened the proposed visit to Cincinnati so that but little time was permitted for a conference at the university. Professor Faig acted as host in the absence of Dean Schneider, and contributed to the information which the President of the S. P. E. E. was seeking.

At Columbus much interest in the work of the Society was manifested at a meeting of all but two members from the large membership at The Ohio State University. At a luncheon given at the Union an announcement of the plans for the Princeton meeting was made. This was followed by remarks from several of the members on the helpful character of the S. P. E. E. meetings, the desirability of gaining a more intimate acquaintance with members from other institutions, and

pleasant allusions to the very successful meeting at Minneapolis. Perhaps the most helpful part of the tour was the long conference with Professor Magruder, who was able to put the President in touch with many important phases of the life of the Society and thus insure a greater degree of continuity in its work. Nothing seems more important to the healthy growth of the S. P. E. E. than the rounding out and completion of many of the important movements which have already been initiated.

The good work of Professor Magruder was continued by President Howe, of Cleveland, where the courtesy was granted of laying the plans of the Society before the faculty of the Case School of Applied Science.

At Ithaca the entire time was consumed in lengthy conferences with the Secretary, an examination of the working details of his office, and an evening with Vice-president Jacoby.

It is not possible at this time to even briefly mention many of the suggestive criticisms that have been made on the work of the Society, but it is hoped that the good seed which has been sown by officers and members may bear fruit in a most successful convention, and the only regret suggested by this tour of inquiry is in its brevity. This experience has also emphasized the importance of a more frequent exchange of thought on the part of our members than is afforded by the annual meeting, and the possible advantages to be derived from occasional sectional meetings. Of course we should not forget that the pages of the BULLETIN are always open to the members, and much discussion may be profitably conducted therein.

REPORT OF THE COMMITTEE ON IMPROVEMENT IN MECHANICAL LABORATORY INSTRUCTION.

The committee submits the following:

1. The committee does not think an interchange of thesis subjects between the different colleges is advisable owing to peculiar conditions in various laboratories. They recommend

however that the laboratories work in conjunction with the research committees of the national societies.

2. The committee is of the opinion that thesis work of the nature of an investigation should be given only to those students of exceptional ability, who have proven their ability, and should not be given to students who have not shown ability. In some institutions this may only be allowed in a fifth year, and following the graduation of the student.

3. The committee has no subjects to suggest for subjects of investigation, and refers to those suggested by the research committees of the national societies.

4. The committee believes that the functions of the mechanical laboratory are as follows:

(*a*) To familiarize the student with machines, their operation, care and adjustment.

(*b*) To train the student to care for instruments, to calibrate them, and to know their accuracy and limitations.

(*c*) To fix the conceptions of the class-room by making these real and by illustrating the application of theory to practice and the limitations of the application.

(*d*) To train the student in the methods of commercial testing of machinery.

(*e*) To train the student in the methods of engineering research and investigation.

(*f*) To train the student in the making of reports and to present results of work in proper form.

(*g*) To make engineering investigations for the public and for the profession.

5. To obtain these results so that the functions may be realized, the committee recommends:

(*a*) That the experiments be planned to give the student facility in handling instruments and to impress on him the necessity for calibration of all instruments, the method for proper use and the limitations which are imposed upon them. Moreover, although planned for technique, these experiments should point the way to investigations and the student should

be taught to consider his results to see if any general conclusion can be drawn.

(*b*) That students should connect and set up apparatus and machines except where the time used for this would be excessive. Students should care for all apparatus and return it to its proper place after working with it. They should clean all machines at the end of the experiment and should be held financially responsible for breakages through carelessness or neglect.

(*c*) That the number of experiments be so limited that time may be given to all details. The course should be so planned that the detail work becomes gradually more involved, but in such a way that previous experience will reduce the time required by its consideration.

(*d*) That log sheets should be printed and given to the students to illustrate correct methods of tabulation and to save time.

(*e*) That experiments be scheduled and limited time be given to each experiment. Time beyond that scheduled must be made from other time. Grades given for laboratory work should be based partially on this element of time and students should be made aware of this.

(*f*) That concise reports should be made on all experiments.

(*g*) That discipline in regard to work in the laboratory and to punctuality in making original reports and their correction is important. Insistence on promptness in reporting for work and in handing in reports should be the aim of every laboratory.

6. The committee is of the opinion that experiments on machine tools should be conducted as part of the work of the shop courses.

Respectfully submitted,

ARTHUR M. GREENE, JR.,
Chairman,
C. RUSS RICHARDS,
W. F. DURAND,
C. C. THOMAS,
J. T. FAIG, *Committee.*

COUNCIL ACTIONS.

By letter ballot, dated Nov. 15, the Council elected the following to membership. (*Individuals*) Messrs. F. G. Allen, T. A. Blair, I. C. Crawford, G. H. Denny, A. B. Domonoske, J. M. Gallalee, Roy Kegerreis, R. B. Keller, Louis Mitchell, A. S. Naidu, H. C. Phillips, J. C. Potter, R. W. Thoroughood, and G. D. Walters, whose applications are listed on page 5 of the November BULLETIN; also Messrs. F. R. Finch and J. A. Kostalek, whose applications are listed on page 5 of the September BULLETIN. (*Institutions*) University of California, Case School of Applied Science, Clemson A. and M. College, The George Washington University, Georgia School of Technology, Harvard University, Iowa State College, The University of Kansas, Miami University, New York University, The University of North Dakota, Notre Dame University, Rhode Island State College, Rochester Athenæum and Mechanics Institute, Stevens Institute of Technology, Syracuse University, Throop College of Technology, U. S. Naval Academy and Worcester Polytechnic Institute, whose applications are listed on page 5 of the November BULLETIN; also the following not previously listed:

STATE UNIVERSITY OF OKLAHOMA, Norman, Okla., Stratton D. Brooks, President 1913
UNIVERSITY OF WASHINGTON, Seattle, Wash., Thos. F. Kane, President 1913

By letter ballot, dated Dec. 15, the Council elected the following, not previously listed:

INDIVIDUALS.

BELSKY, C. J., Instructor in Electrical Engineering, University of Pennsylvania, Philadelphia, Pa..... 1913
DAVIS, GEO. J., JR., Dean and Professor of Civil Engineering, University of Alabama, University, Ala..... 1913
DURHAM, GLEN G., With the Crocker-Wheeler Company, 616 Heed Bldg., Philadelphia, Pa..... 1913

GODFREY, HOLLIS, President, Drexel Institute, Philadelphia, Pa..... 1913
JOHNSON, WM. F., Instructor in Electrical Engineering, University of Pennsylvania, Philadelphia, Pa..... 1913
MOORE, G. R., Instructor in Civil Engineering, University of Cincinnati, Cincinnati, O..... 1913
NEWTON, GUY D., Instructor in Mechanical Drawing and Descriptive Geometry, University of Missouri, Columbia, Mo..... 1913
SELLERS, ROBT. R., Instructor in Civil Engineering, University of Florida, Gainesville, Fla..... 1913
STRONG, ALBERT J., Instructor in Mechanical Engineering, University of Florida, Gainesville, Fla..... 1913
WILSON, JOHN F., Instructor in Electrical Engineering, University of Michigan, Ann Arbor, Mich..... 1913

INSTITUTIONS.

CORNELL UNIVERSITY, Ithaca, N. Y., Jacob Gould Schurman, President 1913
UNIVERSITY OF MICHIGAN, Ann Arbor, Mich., H. B. Hutchins, President 1913
UNIVERSITY OF PITTSBURGH, Pittsburgh, Pa., Samuel B. McCormick, Chancellor 1913

APPLICANTS FOR MEMBERSHIP.

INDIVIDUALS.

BELL, J. M., Professor of Physical Chemistry, University of North Carolina, Chapel Hill, N. C. 1914
CARPENTER, RANDLE C., Professor of Mechanical Engineering, Mississippi A. & M. College, Agricultural College, Miss..... 1914
CHANEY, G. A., Assistant Professor of Mathematics, Iowa State College, Ames, Ia. 1914
CHARAVAY, M. A., Instructor in Experimental Engineering, Stevens Institute of Technology, Hoboken N. J. 1914
CODWISE, H. R., Assistant Professor of Civil Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1914
DOUGHERTY, N. W., Instructor in Civil Engineering, Cornell University, Ithaca, N. Y. 1914
ELY, JOHN A., Professor of Surveying and Engineering, St. Johns University, Shanghai, China 1914
FISK, IRA W., Associate in Electrical Engineering, University of Illinois, Urbana, Ill. 1914
GEORGE, S. G., Assistant Professor of Civil Engineering, Cornell University, Ithaca, N. Y. 1914

APPLICANTS FOR MEMBERSHIP.

GUMMERE, H. V., Professor of Mathematics, Drexel Institute, Philadelphia, Pa. 1914

HALL, JAMES A., Instructor in Mechanical Engineering, Brown University, Providence, R. I. 1914

HENDERSON, J. M., President of Board of Trustees, The Case School of Applied Science, Cleveland, O. 1914

HITCHCOCK, G. P., Vice Chairman of Faculty and Assistant to the Secretary, Pratt Institute, Brooklyn, N. Y. 1914

HOSMER, GEO. L., Assistant Professor of Civil Engineering, Massachusetts Institute of Technology, Boston, Mass. 1914

HOUSTON, HALE, Professor of Civil Engineering, Clemson A. & M. College, Clemson College, S. C. 1914

LITTLE, A. P., Associate Professor of Electrical Engineering, Oklahoma A. & M. College, Stillwater, Okla. 1914

MACDONALD, S. L., Head of the Department of Mathematics, Colorado State Agricultural College, Ft. Collins, Colo. 1914

MCMURTRAY, H. D., Assistant Professor of Physics, Mississippi A. &. M. College, Agricultural College, Miss. 1914

MISER, W. L., Instructor in Mathematics in College of Engineering, University of Minnesota, Minneapolis, Minn. 1914

NELSON, J. R., Assistant Professor of English in the Dept. of Engineering, University of Michigan, Ann Arbor, Mich. 1914

NUGENT, P. C., Professor of Civil Engineering, Syracuse University, Syracuse, N. Y. 1914

OLMSTED, CHAS. T., Instructor in Applied Mechanics and Hydraulics, Case School of Applied Science, Cleveland, O. 1914

PEARSON, R. A., President, Iowa State College, Ames, Ia. 1914

RADEBAUGH, G. H., Instructor in Machine Shop Practice, University of Illinois, Urbana, Ill. 1914

REED, PERCY L., Instructor in Civil Engineering, Drexel Institute, Philadelphia, Pa. 1914

ROBERTSON, JOHN E., Instructor in Civil Engineering, Mississippi A. & M. College, Agricultural College, Miss. 1914

SALAZAR, ARTURO EDMUNDO, Professor of Applied Physics and Electrical Engineering, Universidad de Chile, Santiago de Chile, S. A. 1914

SEATON, L. F., Assistant Professor of Agricultural Engineering, University of Nebraska, Lincoln, Nebr. 1914

SHEDD, THOS. C., Assistant in Mechanical Engineering, Brown University, Providence, R. I. 1914

SKELTON, R. H., Instructor in Sanitary Engineering, Yale University, New Haven, Conn. 1914

SMITH, RICHARD R., Manager, College Department, The Macmillan Company, 66 Fifth Ave., New York, N. Y. 1914

SMITH, WM. G., Assistant Professor of Kinematics and Descriptive Geometry, Armour Institute of Technology, Chicago, Ill..... 1914
STARKEY, L. C., Professor of Mechanical Engineering, Drexel Institute, Philadelphia, Pa..... 1914
STELZNER, W. B., Adjunct Professor of Electrical Engineering, University of Arkansas, Fayetteville, Ark..... 1914
SUTHERLAND, C. H., Instructor in Civil Engineering, Massachusetts Institute of Technology, Boston, Mass..... 1914
THOMPSON, R. E., Chief Engineer, Ft. Smith Light & Traction Co., Ft. Smith, Ark..... 1914
WILSON, WILBUR M., Assistant Professor of Structural Engineering, University of Illinois, Urbana, Ill..... 1914
WINTER, J. W., Instructor in Mechanical Engineering, Drexel Institute, Philadelphia, Pa. 1914
YATES, S. S., Instructor in Civil Engineering, Harvard Graduate School of Engineering, Cambridge, Mass..... 1914

INSTITUTIONS.

DREXEL INSTITUTE, Philadelphia, Pa., Hollis Godfrey, President... 1914
STATE UNIVERSITY OF IOWA, Iowa City, Ia., John G. Bowman, President. 1914
UNIVERSITY OF NEBRASKA, Lincoln, Nebr., Samuel Avery, Chancellor. 1914
TUFTS COLLEGE, Tufts College, Mass., Wm. L. Hooper, Acting President 1914

NOTICES.

The Bureau of Standards announces an examination to be held by the United States Civil Service Commission on January 21 and 22, for the position of male laboratory assistant at a salary of from $900 to $1200 per year. The secretary of the Society can supply application forms or they can be secured from the Department of Commerce, Bureau of Standards, Washington, D. C.

Mr. Frank B. Gilbreth announces a summer course in scientific management for college professors only. It will be held for four weeks beginning the first Monday in August, in Providence, R. I.

Ten research fellowships, each with an annual stipend of $500 are offered by the University of Illinois Experiment Station. Appointments are made and must be accepted for two consecutive college years, after the expiration of which period the Master's degree will be granted if all requirements are met. Not more than half of the time of the fellows is required in the departments to which they are assigned, the balance being available for graduate study. Appointments are made in March and applications must be in the hands of the Director not later than February first. Preference will be given to men who have had some practical engineering experience.

OTHER SOCIETIES.

The Chicago Section of the American Chemical Society has appointed a committee to coöperate with the mayor of the city in solving the vexed problems connected with garbage disposal. The committee consists of Professors Julius Stieglitz, of the University of Chicago, J. H. Long, of Northwestern University, and Harry McCormack, of the Armour Institute of Technology.

Through the efforts of the mining engineers, who have received hearty coöperation, a number of secretaries of national societies met in New York on December 13 to consider ways and means for avoiding conflicts in convention dates. As a result of the conference a schedule of meeting dates has been prepared in preliminary form and distributed. It is interesting to note that, so far, there is no other meeting scheduled for the dates selected by this society.

Mr. P. S. Millar, Secretary-Treasurer of the Committee on Organization of the International Electrical Congress, 80th St. and East End Av., New York, makes the following announcements.

The International Electrical Congress is to be held at San Francisco September 13th to 18th, 1915, under the auspices of the American Institute of Electrical Engineers by authority of the International Electrotechnical Commission, and during the Panama-Pacific International Exposition. Dr. C. P. Steinmetz has accepted the Honorary Presidency of the Congress. The deliberations of the Congress will be divided among twelve sections which will deal exclusively with electricity and electrical practice. There will probably be about 250 papers. The first membership invitations will be issued in February or March, 1914.

Attention is drawn to the distinction between this Electrical Congress and the International Engineering Congress which will be held at San Francisco during the week immediately following the electrical congress. The engineering congress is supported by the Societies of Civil, Mechanical and Marine Engineers and by the Institutes of Mining and Electrical Engineers, as well as by prominent Pacific Coast engineers who are actively engaged in organizing it. This Congress will deal with engineering in a general sense, electrical engineering subjects being limited to one of the eleven sections which will include about twelve papers, treating more particularly applications of electricity in engineering work.

The meeting of the International Electrotechnical Commission will be held during the week preceding that of the Electrical Congress.

The Fourth Annual Good Roads Congress and the Fifth Good Roads Show were held in conjunction with the Tenth Annual Convention of the American Road Builders' Association at the First Regiment Armory in Philadelphia from December 9th to 12th, 1913. The attendance of over three thousand included a large number of prominent highway officials, engineers, chemists and contractors from many parts of the United States and Canada. Technical sessions for the consideration of problems in highway engineering relative to

administration, organization, construction and maintenance occupied six half-day periods. A total of sixty-five papers constituted the program. An attentive and appreciative audience filled the convention hall at the several sessions. A study of the comprehensive exhibits of highway materials and machinery, and of those prepared by the United States Office of Public Roads, and by various states and universities, provided a rare opportunity for a visual study of the latest developments in many fields of highway engineering.

A. H. BLANCHARD.

LETTER TO THE EDITOR.

Dear Sir: I have a few words to add by way of discussion of Director Person's excellent address on "Academic Efficiency" in which he enumerated a few problems which might be scientifically investigated by the "Statistical Bureau" which he advocates.

I should like to add one more problem to this list, namely, "Is there any correlation between the ability shown by students in the various subjects taught in college and the vocations into which these men finally come after graduation?" For example, will students who are good in abstract theory (calculus, economics, etc.) and who are poor in applied mathematics (analytical geometry, mechanics, etc.) be likely to become designers of detailed engineering structures, or will they not more often become scientific investigators or instructors?

It would seem that if any conclusions could be reached from such an investigation, they would be of great value if placed at the disposal of "student advisors."

I am yours truly,

W. H. RAYNER.

URBANA, ILLINOIS.

PROFESSOR ARTHUR J. FRITH.

1852–1913.

Professor A. J. Frith, who died in Chicago on November 12, 1913, was born in Philadelphia, Pa., on February 23, 1852. He was a graduate of the Rensselaer Polytechnic Institute, where he received the degree of C.E. As a young man he worked in steel and rolling mills and was sent to England for special information in this line. He then taught thermodynamics and mechanical engineering subjects at Lehigh University, which work he left to become designer, erector and finally assistant chief engineer on government work in connection with the Mississippi River Commission. He was next a designer for the Newark (N. J.) Machine Tool Works and here originated special methods for calculating the strength of machine-tool parts. He was a special designer on coal-handling plants for the C. W. Hunt Co. of New York and followed the same line with the Trenton (N. J.) Iron Co. He was assistant chief engineer and designer with the New York branch of the Diesel Engine Co. and secretary of the Washington Co. (N. Y.), steam-plant contractors. As a consulting engineer in New York City he specialized on research work in heat, gas and steam engines. Later he accepted the position of Associate Professor of Mechanical Engineering at the Armour Institute of Technology, which he held at the time of his death.

Professor Frith was the author of a number of scientific papers and secured several important patents. His special research was in "boiler efficiency," "regenerator efficiency," "true gas-engine efficiency" and "entropy analysis." He was a member of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education and the Society of Automobile Engineers.

PROFESSOR WARREN BABCOCK

1866–1913.

Professor Babcock was born at Ypsilanti, Mich., September 15, 1866 and died June 3, 1913. His elementary education was obtained in the public schools of Milan, Mich., from whence he came directly to the Michigan Agricultural College, graduating with the class of 1890. In the following year, he became instructor in mathematics in his alma mater, and in the course of the succeeding years he was advanced to full charge of the department. Besides his departmental duties, Professor Babcock had been for many years secretary of the faculty, which work brought him into intimate connection with the administrative affairs of the college. In both capacities his associates have recognized his ability and efficiency.

Professor Babcock always had the courage to stand fearlessly by his convictions. The following quotation from a short characterization in a recent 'Wolverine' epitomizes his character: "When he talked he looked one straight in the eyes and a square deal followed."

To the community his death results in the loss of a public-spirited and estimable citizen. In the early years of the little city adjoining the campus, when many peculiarly difficult problems demanded careful solution, Professor Babcock, as mayor, gave unsparingly of his time and ability, and rendered conspicuously efficient public service. In more recent years he has been a member of the local board of education. In these official capacities the same characteristics, so markedly manifest in his college duties, predominated. No better testimony in appreciation of his work can be offered than that of the reluctance with which his fellow citizens consented to heed his personal desire to be relieved from the responsibility of public office.

During the last five years of his life Professor Babcock was an interested member of this society.

A. R. Sawyer.

QUESTIONS AND KINKS.

Determination of Hook Gauge "Zero Reading."

The value of the head "H" to be inserted in a weir formula is usually determined by using a hook gauge placed in the channel of approach or in a well connected with the channel by piping. In determining the reading of the hook gauge of the weir notch, the "zero" reading, it is customary to use a the weir notch, the "zero" reading, it is customary to use a spirit level and a level board or a surveyor's level and a level rod. Careful work with good instruments is necessary to avoid errors which will have an appreciable effect upon the result. If the weir happens to be a V-notch weir, special methods must be employed.

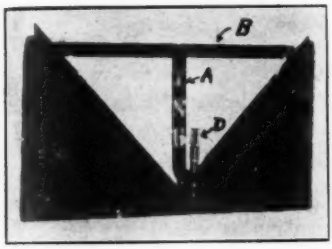

Fig. 1.

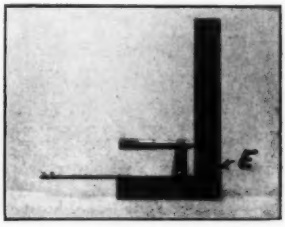

Fig. 2.

The device described below is applicable to any form of notch and eliminates all spirit-level work. Near the upper end of a piece *A*, Fig. 1, is a cross-bar, *B*, long enough to rest against the upstream face of the weir plate. A clamp at the lower end of *A* carries a micrometer head, *D*, with its axis parallel to the plane of *A* and its spindle ground to form a point gauge. The lower end of *A* rests on the bottom of the weir notch and, in order to adapt it to all conditions, it is cut to an angle somewhat more acute than the angle of the smallest V-notch in which it is likely to be used.

The bar, A, is placed on the face of a try-square, E, Fig. 2, the end of A just touching the blade of the square. The micrometer head is turned until the point of the spindle is also just touching the blade and the reading is noted. Call this M_1 The level of the water in the channel of approach is brought to about a quarter inch from the bottom of the weir notch and a reading is made on the hook gauge. Call this G_1. The device is then set up in the notch as shown in Fig. 1, A being plumbed by eye and maintained in a vertical plane by resting the bar B against the weir plate, which should be vertical. The micrometer head is then turned until the point on the end of the spindle just touches the water. Call the reading M_2 The difference between M_2 and M_1 is the distance from the bottom of the notch to the surface of the water. This distance combined with the reading G_1 will give the reading of the hook gauge when the point of the hook is at the same level as the bottom of the notch.

H. E. EHLERS.

LEVELLING LABORATORY TABLES.

The floors of our electrical laboratories are of cement, and consequently there is some unevenness which has been annoying in that it allowed our test tables to rock, an unpleasantness which all men, of course, have experienced. We overcame this difficulty very satisfactorily by deliberately shortening one leg of the test table and attaching to that leg an ordinary door check, such as is used to hold doors open. After the table is set in the desired place simply pressing down this check with the foot balances the table nicely so that there is absolutely no unsteadiness. These checks cost a very small sum and have been found to be very durable when used for this purpose.

R. W. SORENSEN.

COLLEGE NEWS.

Universidad de Chile.—Professor Cruchaga reports that Professor Obrecht is holding a series of conferences in the university auditorium on the mathematical theory of electricity and magnetism. Professor Obrecht is the director of the astronomical observatory at Santiago and is a graduate of L'Ecole Polytechnique de Paris. Professor Cruchaga expresses great appreciation of the influence of the United States on the educational development of South America.

University of Colorado.—In order to meet a demand for specially trained men to serve as health officers of cities and to provide more adequate preparation for graduates in engineering who desire to enter the sanitary branch of the profession, the graduate school of the University of Colorado through the college of engineering and the school of medicine now offers courses leading to the degree of Master of Science in Public Health, Master of Science in Sanitary Engineering and Doctor of Public Health. The last two courses are open to technical graduates of the University of Colorado and other approved schools who have specialized in sanitary engineering and the first and last are open to those who hold the degree M.D. from the University of Colorado or other schools of similar standing.—The courses of study in addition to such technical subjects as advanced bacteriology, water and food analysis, sewage and garbage disposal, sanitary design, ets., include public health law, municipal government, social and vital statistics, immunity and epidemiology.—All of these degrees are granted only upon the completion of the prescribed work in residence. The degree Master of Public Health or Master of Science in Sanitary Engineering may be obtained in one year after graduation from the proper undergraduate course while the degree Doctor of Public Health may be secured after two years of graduate study.

Columbia University.— The following will deliver lectures during the coming season in the course in highway engineering: John A. Bensel, New York state engineer; William H. Connell, chief, Bureau of Highways and Street Cleaning, Philadelphia; C. A. Crane, secretary, The General Contractors' Association; W. W. Crosby, chief engineer, Maryland Geological and Economic Survey, and consulting engineer; Charles Henry Davis, president, National Highways Association; John H. Delaney, commissioner, New York State Department of Efficiency and Economy; A. W. Dow, chemical and consulting paving engineer; H. W. Dunham, chief engineer of highways, Borough of Manhattan, New York City; C. N. Forrest, chief chemist, New York Testing Laboratory; Walter H. Fulweiler, chief chemist, United Gas Improvement Company; Frank B. Gilbreth, consulting engineer; George P. Hemstreet, superintendent, The Hastings Pavement Company; Samuel Hill, president, American Road Builders' Association; D. L. Hough, president, The United Engineering and Contracting Company; J. W. Howard, consulting engineer; Arthur N. Johnson, state highway engineer of Illinois; William H. Kershaw, manager, Paving and Roads Division, The Texas Company; Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment, New York City; Harold Parker, first vice-president, Hassam Paving Company; Paul D. Sargent, chief engineer, Maine State Highway Commission; Philip P. Sharples, chief chemist, Barrett Manufacturing Company; Francis P. Smith, chemical and consulting paving engineer; Albert Sommer, consulting chemist; George W. Tillson, consulting engineer to the president of the Borough of Brooklyn, New York City.

College of Hawaii.— Professor J. S. Donaghho has been appointed acting dean pending the appointment of a president to succeed J. W. Gilmore who resigned last June to take charge of the department of agronomy at the University of California.—During the coming year an addition to the testing laboratories of the engineering department will be con-

structed. The present road-testing equipment will be moved to the addition and more apparatus purchased so that a complete laboratory will be available for the use of students electing this branch of engineering.—The department of sugar technology is in charge of Professor H. S. Walker. The institutions offering courses in this work, which really combines agriculture and engineering, are not numerous. The College of Hawaii, because of its location in a community whose main agricultural crop is sugar, is particularly well located to give instruction in this branch.

University of Illinois.—Recent statistics show a total of 1,178 students in engineering, approximately the same number as last year. The largest numerical growth is in architectural engineering and the largest percentage growth is in mining engineering.

University of Kansas.—The following new appointments to the faculty of the school of engineering have been made: Mr. Goldwin Goldsmith becomes professor of architecture and head of the department of architectural engineering. He comes from his practice as a member of VanVleck & Goldsmith, architects, New York City, and will take up his duties at Lawrence in January.—Mr. W. C. McNown has been made assistant professor of civil engineering. He has had several years of practical work as a consulting engineer and has previously taught at Cornell University.—Mr. Frank L. Brown comes to Kansas as assistant professor of mechanics from the department of mechanics at the University of Colorado.—Mr. F. R. Hesser has been appointed assistant professor of sanitary engineering to assist in the work of the engineer of the State Board of Health.—Mr. Samuel McMullen has been added to the shop staff with the rank of assistant professor. A portion of Professor McMullen's time will be devoted to the vocational instruction given under the auspices of the extension division of the university.—Professor C. A. Johnson, of the Electrical Engineering Department, has returned to the university after a short leave of absence during which

he was employed by the United States government in connection with the electrical distribution systems at the Panama Canal.—The senior engineering students made their annual inspection tour during November. Five members of the faculty accompanied them.

State University of Kentucky.—The Marathon Motor Works has donated an automobile chassis to be tested out on the automobile testing floor.—Mr. C. A. S. Howlett of the General Electric Company recently delivered an address on the subject of sales engineering, and a lecture in which he attempts to prove that the world is concave instead of convex, and that we live on the inside of a hollow sphere.—A recent feature of the weekly "magazine digest" meetings was one devoted to a debate as to which of five technical journals are the most useful to the mechanical and electrical engineer.

University of Maine.—At a recent meeting of the Maine Engineering Society held at Rumford, Dean H. S. Boardman was elected president for the coming year. Dean Boardman and all of the other officers elected are alumni of the university. Mr. F. B. Slocum, of the Continental Iron Works of Brooklyn, N. Y., gave an address before the university student branch of the A. S. M. E. on "Internal Furnace Boilers." He dwelt at some length on the adaptability of the Morison Suspension Furnace to any type of internally-fired boilers, either fire-tube or water-tube, and the advantages of these furnaces over those of the plain type. In the 30,000 internally-fired boilers in use in this country there is no record of a single explosion. The difference in number of accidents as compared with those occurring with externally-fired boilers is due largely to the fact that in internally-fired boilers the flames do not come in contact with the shell, and the firebox is entirely surrounded by water. The Continental Iron Works built the famous *Monitor* and Mr. Slocum gave a very interesting account of its erection. From the time the keel was laid until it was in the water was exactly

one hundred days. In the same docks were built many more steel vessels in later years.

Massachusetts Institute of Technology.— The increasing interest of foreigners in the instruction in mining engineering given in this country is indicated by the presence of two Russian graduate students at the "Tech" this year.—The mining laboratory equipment has been considerably augmented recently. Until the completion of the new laboratory considerable apparatus must be stored.

New York University.—Students are now being enrolled for the February–September course in engineering which has recently been made a part of the college curriculum. The special announcement of the school of applied science states that in order to meet the needs of high-school students graduating in February, special courses have been established which will begin in February and continue until September. Students completing successfuly these freshman courses will be admitted to full sophomore standing at the opening of the usual fall term.

Northwestern University.—In September, 1913, the college of engineering entered upon its fifth year. The four years just completed were essentially years of construction, during which the laboratories were gradually equipped, and the teaching force and the various courses organized in accordance with the general policy of the college, which includes many departures from ordinary practice. The registration to November 13 is eighty, an increase of thirty-six per cent. over the total registration of 1912–13.

University of Oklahoma.—Mr. George W. Knox, of the Knox-Haskitt Engineering Co., of Chicago, and general manager of the Oklahoma Railway Co., of Oklahoma City, has accepted a lectureship in electric railway engineering. He has had more than twenty-five years of experience in this line.—Mr. James F. Noble, chief engineer and plant superintendent of the Pioneer Telephone and Telegraph Co., has

accepted a lectureship in telephone and telegraph engineering. He installed the first long-distance telephones in Oklahoma and has been in his present position since the organization of the company.—Mr. W. R. Malinand, of H. M. Byllesby & Co., of Chicago, general manager of the Oklahoma Gas & Electric Co., has held the position of lecturer in electrical power plant engineering for some time and the other lectureships are a continuation of the policy of the school of electrical engineering.

Purdue University.—The following appointments have been made in the school of civil engineering: H. B. Smith, University of Virginia, '09, who served the Isthmian Canal Commission and was instructor in the University of Iowa, comes from valuation work in the state of California to be an instructor in railway engineering. A. L. Dierstein, University of Colorado, '11, who was with the American Bridge Co., at the Gary Plant, and later with the department of design of the Chicago, Milwaukee and St. Paul Ry., becomes an instructor in structural engineering. W. E. Stanley, Kansas Agricultural College, '12, bridge inspector with the Kansas state engineer and afterwards employed with a U. S. surveyor in California, has been appointed an assistant in surveying.

University of Santa Clara.—The University of Santa Clara was founded in 1851 but the work was confined to the college of liberal arts until the summer of 1912 when the colleges of engineering, law and medicine were created. In September, 1912, the college of engineering opened its doors with Professor Joseph L. Donovan in charge of the department of civil engineering and Professor George L. Sullivan in charge of the department of mechanical and electrical engineering .—During the summer of 1913 a pattern shop was equipped and a number of instruments purchased for surveying, testing, etc. The faculty is of the opinion that the primary requisites for an engineering education, aside from those things that promote character-building and good citi-

zenship, are mathematics, English, physics, chemistry and mechanics. At the same time the faculty recognizes the fact that an engineer must be able to apply his science to practical work and furthermore that pure science itself is apt to be very uninteresting to students, hence it is that the laboratories are being designed to enable the student to see the practical applications of science and mathematics, to get some practice in applying his knowledge to the solution of practical problem and to acquire some knowledge of and dexterity in the use of tools, instruments and machines. For these reasons the equipment will not be elaborate and the attempt will be made to illustrate modern applications of scientific principles rather than all phases of modern engineering. Hence, while all the equipment will be strictly modern and of the latest type, no attempt will be made to have all types represented. While the necessity for an elaborate equipment for graduate work is recognized, it is believed that this often leads to undergraduates being taught merely to handle a large variety of instruments and machines without thoroughly understanding the principles applied in any of them. —The beginning of the work has been greatly facilitated by the help of the old and well-established departments of English, mathematics, and the sciences.

Throop College of Technology.—The College began its fourth year's work on the new campus with an increased enrollment and an encouraging outlook. The staff of instruction has been strengthened by the appointment of Franklin Thomas as associate professor of civil engineering. Professor Thomas graduated from the University of Iowa and later spent a year at McGill University, doing special work on reinforced concrete. Since leaving McGill he has been connected with the construction of a 10,000-h.p., 300-ft. head, hydro-electric plant near Cobalt, Ontario, and has also been for two years connected with the Alabama Power Company in connection with water power projects. In addition to this prac-

tical work, for two years he was connected with the faculty of the engineering department of the University of Michigan.—Other new appointees are Howard J. Lucas, B.A. (The Ohio State University), M.A. (Chicago), as instructor in chemstry in place of Charles A. Brautlecht, resigned, and Miss Jessie Douglas, librarian, in place of Miss Gladys Brownson, resigned.

Worcester Polytechnic Institute.—The coming of Dr. Ira N. Hollis, for twenty years senior member of the Harvard engineering faculty, to the presidency of the Worcester Polytechnic Institute, marks the opening of a new era at W. P. I. Changes in the corps of instruction have been few this year. The department of English and modern languages has been divided, Professor Z. W. Coombs, for many years head of the department, retaining the department of English, while Dr. O. W. Long comes from the Massachusetts Institute of Technology to take charge of the department of French and German.—Assistant Professors D. L. Gallup and Frederic Bonnet, Jr., have been advanced to full professorships in gas engineering and chemistry, respectively.—C. J. Adams, instructor in modern languages, has been made assistant professor in English, and Dr. D. F. Calhane, instructor in industrial and electro-chemistry, has also been appointed assistant professor in his department.—P. W. Brouwers, '13, returns to the Institute as instructor in mathematics, and G. S. Simpson, who graduated from the University of Maine last June, becomes assistant in chemistry, replacing E. B. Peck, who has taken up a course of graduate work at the Massachusetts Institute of Technology.—The resignation of Rev. Austin S. Garver from the board of trustees occasioned a vacancy that was filled by the election of Rev. Edwin M. Slocombe, pastor of the First Unitarian Church, of Worcester. Another vacancy has since been caused by the death of Fred H. Daniels, a graduate of the Institute in the class of 1873, and chairman of the board of engineers of the United States Steel Corporation.

ON ENGINEERING ENGLISH.

BY J. MARTIN TELLEEN,

Professor of English, The Case School of Applied Science.

Some years ago we found engineering writers so frequently offending in the use of English that one of our associates announced the hypothesis that the brain centers concerned in the mental processes of acquiring knowledge of science and knowledge of letters must in someway interfere, so that the development of one prevented the proper functioning of the other. Engineers' English has improved so much in the ten or fifteen years since this suggestion was put forth that, I think, its whimsical physiology is sufficiently disproved.

These are the recent words of Mr. C. B. Going, the editor-in-chief of *The Engineering Magazine*. Regardless of the possible improvement in the use of English by engineers, jeremiads inspired by their deficiency are undoubtedly more numerous to-day than they were ten or fifteen years ago. In fact, almost every address delivered before students on the subject of engineering in its broader aspects harbors criticisms of the engineer for his inability to express himself with the accuracy and good form that his profession demands. In defence the engineer might cite the numerous and constantly increasing charges made against the pupils of the grammar and the preparatory schools, not to mention those made against the graduates of our academic colleges. He might even resort to the charges recently brought against the French schools, schools that have been justly proud of their sustaining the rich literary traditions of the nation. Such a defence is really no defence: it is merely the kind of consolation that may soothe without remedying the transgression.

Granted that the engineer is an offender, the question is: What is the nature of his offense? The answer to this question is largely dependent on a second question: What are the peculiar features of engineering English? Incidentally might be considered the question: Are the scientists themselves taking

steps to eliminate unnecessary lack of uniformity in the many details of engineering composition?

Fundamental to sound exposition is sound thinking. The engineer's application of logic is apparent in his mathematical demonstrations, chemical analyses, and technical diagrams. That he needs, but often fails to recognize the general uniformity and the simple logic inherent in most subjects for written presentation is indicated, for instance, by the expository outlines proposed by the United States Geological Survey to serve its field workers in covering their reports fully and consistently. To help remedy this discrepancy in not adopting the natural, the logical, order is in part the object of the following suggestion made by Professor Dugald C. Jackson at the 1910 meeting of the Society for the Promotion of Engineering Education: "I am strongly in favor of emphasizing the instruction in mathematics, but particularly in calculus, on the side of the interpretation of the meaning of equations into simple terms of English, as the terms of English are those in which one ordinarily thinks, and it is neceessary to make such interpretation in order that the logical processes of mathematics may be incorporated with our ordinary processes of thought and analysis."

The fault of following a slipshod and illogical outline is, of course, not apparent in those forms of composition that are not made up of paragraphs. Such is the case with tables of figures or diagrams, which are often used as complete reports and even as articles for periodicals. In a blue-print diagram that is to be read by several parties with their different points of view the correlation of parts and all other necessary explanations are made by lines, curves, and symbols, most of which are now satisfactorily standardized to make such a composition readily understood without any liability of misinterpretation.

These forms of composition make for conciseness as also does a certain kind of shorthand that results from the extensive use of abbreviations, symbols, signs, and numerals. The anarchy that existed in the use of abbreviations in all forms

of engineering compositions is now being done away with largely as the result of the recommendations of the four national engineering societies, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Mining Engineers. However, there still exists a wide variance in this matter of usage. Some magazines seldom abbreviate; some use abbreviations which are unknown even to their own particular class of readers; others are gradually falling into line and conforming to the recommendations of the four societies. These recommendations consider not only abbreviations, but likewise numerals. The abundance of long compound numbers in engineering articles is the cause of further variance in practice. Rather than avoiding the use of numerals in all cases or going to the other extreme of spelling out such numbers, most engineering publications conform more or less uniformly to their own set of arbitrary rules. Finally, that there is a deplorable lack of uniformity in the matter of writing formulæ is evidenced by the fact that the English Society of Civil and Mechanical Engineers reported in 1884 that the formula for Ohm's Law was expressed in at least thirty different ways. Fortunately, the engineering societies have taken cognizance of the need of uniformity and give promise of taking steps to remedy this cause of confusion.

In the case of the vocabulary we have to consider the relative newness of scientific words. To designate new contrivances, newly discovered elements, etc., old words are frequently used to form compound words. Here arises the question of hyphens. Should *horsepower* be written as two separate words or as a hyphened word or as a solid word? This question of compound words has given rise to innumerable lists and sets of rules, but no list or set of rules is universally satisfactory. Again, the name of some prominent scientist, as Fahrenheit, Galvani, Ohm, Bessemer, Babbitt, and Sherard, soon becomes a common word in engineering terminology. Should such words be written with capital or small letters?

In seeking a precise definition of a word the engineer again encounters a difficulty. For instance, the mineralogist defines the word *rock* as "a mineral or an aggregate of minerals that forms an essential part of the earth's crust" (Van Horn). However, an engineer whose task is to prepare specifications for a contractor must discard such a definition and in self-defence defines the word as "any material geologically in place and of a hardness when first exposed of three or greater in the scale of mineral hardness, which corresponds to the hardness of the transparent variety of calcite" (Chicago Board of Local Improvement). Mention might here be made of the abuse of the word as a provincialism. Mr. T. A. Rickard speaks of its being used in the Lake Superior region to designate profitable copper ore. Several other definitions may be found in any standard dictionary.

To pile up further illustrations is an easy task. Note the word *engineer* with its many significations, as stationary engineer, locomotive driver, mining engineer, social engineer, and efficiency engineer. Consider the difficulty the expert encounters in consulting a standard dictionary, not to mention a textbook, to ascertain a true definition of such words as *hue, ore* and *sound.* Mr. Wright in the BULLETIN of last June gives several interesting illustrations of the difficulty of defining technical words.

That this difficulty is being alleviated is instanced by the fact that the scientific societies are grappling with the problem of nomenclature. The American Association for the Advancement of Science has considered the chemical terms ending in *ide* and *ine.* The International Society for Testing Materials quite recently defined the apparently very ordinary terms, *force, load, pull, thrust, tension, pressure, shear, stress,* and *internal friction.* The American Chemical Society has struggled with several words, among which are found *bronze, iron, steel,* and *Portland cement.*

This more or less general confusion together with the attempt of the scientific societies to bring about uniform practice and precision naturally interests the teacher of English in

an engineering college. To assist him in his work of teaching the requirements of scientific writing he finds himself now provided with several books, among which may be mentioned: "Notes on the Composition of Scientific Papers," by T. C. Allbutt, professor of physics in the University of Cambridge, "Guide to Technical Writing," by A. T. Rickard, former editor of the *Mining and Scientific Press*, "Theory and Practice of Technical Writing," by S. C. Earle, professor of English in Tufts College, "Good Engineering Writing," by H. Frost, engineer and editor, and "Handbook of English for Engineers," by W. O. Sypherd, professor of English in Delaware College.

However, no individual, be he teacher of English or author recognized as an authority, is in position to establish by his own unaided precept and practice uniform usage in all the mooted details of engineering English. The ideal solution would be to have a central board to which such matters might be referred for recommendation. Its province would be to keep in touch with the current use of words and help determine their significations and to pass judgment on all matters of composition. Such a board would have the same field in engineering that the French Academy has in the broad field of the French language.

By virtue of its large membership, which embraces a goodly representation of all engineering societies, the Society for the Promotion of Engineering Education is the logical organization to assume a prominent part in this work. The task is a stupendous one, the undertaking of which calls forth many and seemingly unsurmountable obstacles. Some of these objections were raised at the 1913 meeting in Minneapolis. However, the initiative might be taken by the Society by publishing in its BULLETIN those definitions which have been established by some recognized national or international society and probably taking cognizance of the definitions of recognized experts as well as by recording all authoritative recommendations for uniformity and standardization in all matters of engineering composition.

THE COST OF EDUCATING A STUDENT.

BY C. H. BENJAMIN,

Dean of the Schools of Engineering, Purdue University.

In determining the cost of education, it is necessary to consider as factors:

1. The direct expense in each department such as English, mathematics, etc., due to salaries of instructors and cost of material used.

2. The indirect expense in each department due to the use and care of building and equipment and to the salaries of non-teachers.

3. The general or overhead expense due to the investment in land and buildings for the common use, to the cost of heat, light, power and service and to the salaries of administrative officers.

This division is analogous to that employed by manufacturers in distinguishing prime cost, factory cost and total cost. In applying this to an educational institution, certain modifications are necessary and some divisions must be made in a rather arbitrary manner.

After the total costs above indicated are obtained, they must be apportioned to different departments and courses of study. For this purpose I have used the student hour as a basis, *i. e.*, the teaching of one student for one college hour in any department or course. No distinction is made between class-room, laboratory or field in this unit, because it is assumed that the expenses, especially the overhead expenses, depend on the hours of actual work in the college without any reference to labor of preparation or study.

The cost is determined first in the department, such as mathematics, physics, or civil engineering, and reduced to cost per student hour. The total cost of each department is then divided among the different schools or courses of study such

as science, electrical engineering, etc., in proportion to the number of student hours of mathematics, etc., stipulated in the curriculum of each school.

The cost per student hour of the education of a student taking any particular line of study or registered in any particular school may then be calculated by addition and division.

EXAMPLE.

The process may be illustrated by assuming certain data and following through the various steps of the calculation. Let us assume the following values:

Land in campus	$ 80,000		
Buildings and equipment used in common by all departments and schools	560,000		
Total		$640,000	
Interest at 5 per cent.		$ 32,000	(*a*)
General expense:			
Administrative salaries and salaries of general caretakers	$ 80,000		
Heat, light, power, repairs, improvements, supplies, etc., for the common use	160,000		
Total			
Grand total of general expense shared by all per annum			
Total number of student hours for all students			

$$\text{General expense per student hour} = \frac{272000}{3200000}$$

The above figure ($0.085) represents the cost of each student hour due to general or overhead expense and to this must be added the cost of instruction in any given department.

Let us further consider some department of instruction such as chemistry, and assume the following data:

Building	$100,000	
Equipment	40,000	
Total		$140,000
Interest, etc., at 5 per cent.		$7,000
Salaries:		

Professors	$ 25,000	
Instructors	12,000	
Help	1,000	
Total		$ 38,000
Grand total		45,000

Assuming the number of student hours per annum in chemistry as 270,000 gives the direct expense per student hour as:

$\frac{45000}{270000}$	= $0.167
Add general expense	= 0.085
Total expense per student hour	$0.252

PURDUE UNIVERSITY.

I have made such an estimate as is outlined above for the various departments and schools of the university with which I am connected.

The estimated values of land, buildings, and equipment were taken from last year's inventory and are as accurate as it is possible to make them. The most of the buildings were listed at cost but in the case of equipment, allowance was made for depreciation.

The buildings and equipment included in general expense account are as follows: Business offices; auditorium; armory; gymnasium; museum; library and heating plant.

An arbitrary charge of five per cent. was made to cover interest on this investment. Since the maintenance charges and insurance appear as a part of the running expense, the figure named is apparently reasonable.

The general expense column contains the following items in addition to the interest charges above mentioned: Salaries of administrators and other non-teachers; heat, power and light; care of buildings and grounds; insurance; printing and publishing; repairs; water; express and freight; betterment; labor, miscellaneous; supplies; postage, telephone and telegraph; and miscellaneous.

The following is a summary of the general expense:

Interest on investment	$20,000	
Salaries	39,780	
Miscellaneous expenses	83,670	
		$143,450
The total number of student hours per annum was for 1912–13		1,616,900
The general expense per student hour is thus		$0.0887

The land and buildings pertaining to the farm and to the School of Agriculture are used to a large extent in common by agricultural students and are not used by students in other schools. These formed the basis of another general expense account which was divided among the departments of this school in proportion to the number of student hours in each.

There follows a summary of this account:

Value of land, live stock, buildings and equipment		$257,385
Interest at 5 per cent., call	$ 13,000	
Administrative and general salaries	13,100	
	$26,100	
Total student hours	209,400	
Expense per student hour $\frac{26100}{209400} =$	0.1245	
General expense	0.0887	
Total	0.2132	

It is evident that what is thus assessed as a general or overhead expense will, by so much, diminish the direct expense charged against the school.

Departmental Expense.

As has been before noted, the departmental expense involves two items: (1) The salaries of teachers;* (2) the rent of buildings and equipment and the salaries of non-teachers.

To the items mentioned above is added the department's share of the general expense based on its quota of student hours and the sum gives the total cost for educating one student one hour in that department. For illustration, the

*For reasons of accounting, the material used in laboratories, etc., has been included in the general expense, although it properly belongs here.

figures for the department of mechanical engineering are given:

Value of buildings and equipment		$181,450
Rent at 5 per cent.	$ 9,070	
Salaries and wages	26,590	
96,360 student hours at 0.0887	8,545	44,205

$\frac{44205}{96360}$ = $0.46 per student hour.

For the department of dairying in the School of Agriculture, the figures are as follows:

Salaries	$5,100	
20,000 student hours at $0.213	4,260	
		$9,360

$\frac{9360}{20000}$ = $0.468 per student hour.

Departments vs. Schools.

It will be noticed that, in the table which accompanies this article, a distinction is made between a department and a school. For example, by the department of civil engineering is meant the line of studies and work which is taught by the instructors in civil engineering in the class-rooms and laboratories set aside for that purpose.

By the school of civil engineering is meant the course of study pursued by a student who expects to graduate in civil engineering.

In the table the total expense of each department is divided among the several schools in proportion to the number of student hours. The footings of the columns give the total student hours and the total expense per annum for each school. Finally, by division, the expense per student hour is determined.

Conclusions.

The expense per student hour is least in those departments where a large number of students are handled, as in the studies of the freshman year.

The expense is greatest in specialized courses involving small sections and the use of laboratory equipment, as in the agricultural and engineering departments.

The cost of education in the several schools is essentially the same and *averages twenty-five cents per student hour.*

On this basis, the cost of educating a student in this university is about $250 per year or $1,000 for a four year's course.

In the present paper no attempt has been made to apportion the overhead expense exactly, as would be done in a manufacturing business.

This would be possible but would involve much special investigation. It is believed that the student-hour basis is accurate enough for the present purpose.

PART II.

PROCEEDINGS OF THE SOCIETY.

The following papers were presented and discussed at the Minneapolis meeting. Brief written contributions, if sent to the Secretary promptly and if approved by the Publication Committee, will be printed in an Appendix to Vol. XXI of the Proceedings now in press.

CIVIL ENGINEERING THESES.*

BY C. E. SHERMAN,

Professor of Civil Engineering, The Ohio State University.

We regard theses as one of the most important subjects in our course. It would be well if each graduate could prepare several theses in place of one, or at least one in each of the following branches of civil engineering:

1. Complete structural design from inception to maintenance.
2. Much experimentation with digest of results and conclusions.
3. More or less of a literary effort.
4. Pure or applied mathematics.
5. Public engineering projects.
6. Engineering problems largely involving economics.

Of course, time does not permit such a program to be carried out in modern college courses, that is if each thesis completed were really worthy of the name. There is time for only one in the graduating year, and in his earlier years the student has not had sufficient training to enable him to prepare a real thesis. But that it would be highly beneficial to prepare theses in each branch above suggested is shown in the following paragraphs.

1. Structural design in steel is perhaps more easily adaptable to thesis subjects than any other field. Steel highway or railway bridges, viaducts, water towers, gas holders, tall buildings, etc., all furnish problems, the conditions of which may usually be concisely stated and the solving of which furnish exercises in the precise work which is especially needed

* Attention is particularly directed to a booklet entitled "Rules for Thesis Work," printed by the civil engineering department of the University of California and referred to in the February, 1914, BULLETIN of the Society.

by the young engineer. Steel is the structural material *par excellence* for thesis subjects.

2. Civil engineering courses, as compared with those in mechanical and electrical engineering, are deficient in the training furnished by extensive experimental work. This weakness can be corrected by choosing a thesis in a civil engineering subject which will supply practice in rigging up apparatus and overcoming obstacles that arise in using it; in gathering experimental data at first hand; in determining the degree of accuracy attainable, and in digesting results and presenting conclusions. Such theses as the experimental determination of weir coefficients, of the flow in pipes and bends, of measuring the runoff of a stream, experimental studies in strength of materials, testing and reporting on the road materials of a county, etc., furnish training in experimentation.

3. By more or less of a literary effort is meant, for example, a codification of road laws with suggested legislation, or a similar digest relating to county surveyors' duties, or to the practice of civil engineering in general, with suggested legislation, etc. Such a theme would give the practice in using English so badly needed by engineering students, with collateral benefits from the study of legal phraseology. No mathematics, drawing, or experimentation, need be required in such a thesis, and yet its value may be as great as any other.

4. Some of our graduates have made thesis researches along mathematical lines in which they were especially interested. A theoretical comparison of formulæ for columns, or a study of wind stresses in tall buildings, suggests some of the opportunities under this caption. In general however, such theses are better accompanied by experimental investigation, for the engineer is primarily an applied scientist.

5. Public engineering projects furnish fruitful themes for theses. The installation of sewerage systems in small towns and of sewage treatment plants, water supply projects, street and highway improvements and civic betterments of many descriptions, involve the formulating of legal preliminaries

and the preparing of plans and specifications, and give practice in estimating costs of materials and labor.

6. While economics is involved in practically every engineering enterprise, there are some theses that bring this subject to attention more forcibly than others. The economics of motor trucking, the reconstructing of an old railroad to meet new operating conditions, the rearrangement of a factory which has outgrown its facilities, a report on a hydro-electric proposition including an investigation of market conditions (which latter is so often the crucial point in such a project), all forcibly emphasize the part economics plays in engineering.

The above six topics by no means exhaust the available fields, nor do the examples cited under each caption sufficiently display the possibilities under each. The student may have had experience along special lines which he wishes to investigate farther, and may readily take his thesis in such subject. A study of movable dams, of reservoir control of a stream, of a waste disposal plant, of bituminous highway materials, or another subject which has not been extensively treated in his regular course, may be a proper subject for a thesis, if the student is especially interested in any one of them.

Theses afford the student an *extended* individual exercise in correlating his information, in testing and developing his acquired powers, in reaching neatness, definiteness and completeness, in using written and graphic language, and in methods of presenting his ideas formally to the public, with the benefit of a frank criticism on his success in these directions by a qualified and impartial judge. To be sure other college exercises afford opportunity in the directions noted, but they are not sustained enough to give any lasting satisfaction.

Assuming that the student has chosen a subject in which he is thoroughly interested—and his own practical experience together with an explanation of the breadth and possibilities of the fields first listed above by his instructor, can arouse such interest—he can spend time on his thesis more profitably perhaps than on any other single subject in his course.

Collateral advantages of theses are that they may afford opportunity to review a subject of his course which for any reason the student did not thoroughly understand. Theses may lend elasticity to an otherwise necessarily rigid course by supplying an elective. Theses may also advance knowledge by original research. This last, however, is not the main object of a thesis. If a contribution to the world's knowledge can be made in a thesis so much the better, but a thesis should primarily make a contribution to the student's knowledge and power.

Our students have always taken great interest in thesis work, and they won first place on averages against all departments of the colleges in the country in the four thesis contests conducted by the *Engineering News* from 1892 to 1895. The writer used his own graduating thesis to clear up his ideas on a certain phase of drafting, and although such a theme (lying chiefly in field No. 3 above) is usually not so valuable as theses in other fields, still it was something of a lasting satisfaction to him to see the thesis when finished adopted as a text-book at a number of universities.

THE GRADING SYSTEM OF THE UNIVERSITY OF MISSOURI.

BY A. LINCOLN HYDE,

Associate Professor of Bridge Engineering, University of Missouri.

The grading of students of all classes from the kindergarten to the university seems to be a necessary evil. Evil it certainly appears to be regarded by some, and the most disagreeable of the many tasks a teacher is called upon to perform by many. Necessity, nevertheless, it has proved to be for the award of prizes and honors, and it does serve as a stimulus for some, as well as a prod for other students.

Usual Grading Methods Unscientific.

In an article on "Examinations, Grades, and Credits," published in 1905, Professor J. McKeen Cattell calls attention to the scantiness of literature on college grades, and says that it seems strange that no scientific study of the subject of consequence has been made. He states that apparently grades are assigned for moral traits or general impressions as much as for ability and performance. He cites Dr. Galton, Professor Pearson, and others as authorities for the statement that the qualities of ability and performance are distributed in accordance with the curve of error.

In "A Guide to the Equitable Grading of Students," published in 1906, Professor Winfield Scott Hall states that his study in this field was undertaken in response to the inquiry, "Does science offer any solution of the problem of grading?" He regards the percentage system as folly, because it makes slavish work for the teacher, and gives the student false values. The mark, which is merely the teacher's estimate, becomes the student's goal.

Professor Hall summarizes his conclusions from his study of the subject as follows:

1. The marking of students is a measure of psychic function, and yields biological data.

2. All biological data, including student rating, are distributed about a median value in conformity with the law of distribution of biological data, which law is demonstrated to be represented in the binomial curve.

3. Average classes of students, doing honest work and marked equitably, will yield results which when tabulated should conform to the binomial curve; *i. e.*, the number receiving medium marks should far exceed the number receiving high or low marks.

Investigation Shows Wide Variation.

During the year 1907 Dr. Max Meyer, professor of experimental psychology in the University of Missouri, made a study of the grades assigned during the preceding five years by forty teachers in the institution. About the year 1902 the university faculty had voted to adopt the grades *A, B, C, D* and *E, A* signifying the highest rank obtainable and *E* indicating failure. The grade *D* meant that the student had received a "condition" which was to be removed within a reasonable period of time by the performance of additional work or by another examination, in default of which he was to be considered as having failed in the subject.

Dr. Meyer was satisfied that if the number of cases considered was sufficiently large the curve of ability and performance should approximate the probability curve. His investigations revealed a wide variation. As unremoved conditions were treated as failures, he grouped the grades *D* and *E* under a single head, *F*, in his records. At one extreme he found that one teacher, for 623 students included in 29 classes, had given 55 per cent of *A*'s, 33 per cent of *B*'s, 10 per cent of *C*'s, and 2 per cent of *F*'s; while at the other extreme another teacher, for 1903 students in 12 classes, had given 0.5 per cent of *A*'s, 11 per cent of *B*'s, 60.5 per cent of

C's, and 28 per cent of *F*'s. Obviously something was wrong. Assuming that the students had done or were held to honest work, these deviations from the probability curve must have been the result of general impressions. The teachers could scarcely be blamed for the extreme variations. The faculty had not given the matter any great amount of thought and had left the grades undefined. It was assumed that each teacher would know intuitively for what the different grades stood. The results were startling.

Missouri Inaugurates a Scientific Method.

Realizing the desirability of standardization Dr. Meyer read a paper on the subject of student grading before a special meeting of the teachers of the University, and followed this up with another on the same subject which was presented before the Scientific Association. His exposition was so clear and his arguments so convincing that the grading system now in use was shortly thereafter adopted by the university faculty.

Briefly stated the system is as follows: In classes sufficiently large to exclude accidental variations, approximately 50 per cent shall receive the grade *M* (medium); to the great majority of the 25 per cent above *M* the grade *S* (superior) shall be given; and to the few most excellent students the grade *E* shall be assigned; the majority of the 25 per cent below *M* shall receive the grade *I* (inferior), and the minority shall be given the grade *F* (failure).

The question of adhering to the old system of letters, *A*, *B*, *C*, *D*, and *E* was discussed at length and it was believed that there would be less resulting confusion in making the change if new letters were used, and it was decided to adopt the letters *E*, *S*, *M*, *I*, and *F*.

Varying Quantity of Credit on Basis of Quality.

Believing that quality of work should be recognized otherwise than by empty honor, it was agreed that such faculties as so desired should be permitted to give excess credit for

excellent and superior work, and that inferior work might be given reduced credit, no credit of course being allowed for failure. It was at first decided to allow 30 per cent excess credit for *E*, 10 per cent excess for *S*, and to deduct 20 per cent for the *I* grade Later the excess for *S* was changed to 15 per cent. A student in the college of arts and science making all *E* grades may therefore be graduated in three years; one whose average grade is *S* or above may finish in three and one half years; while a student whose average grade is *I* must spend five years in obtaining sufficient credit for the A.B. degree.

Results Achieved.

The system has been in use since the summer session of 1908 and the results may be said to be most gratifying. In the latest cumulative report showing the grading of sixty-one teachers of under courses (freshman and sophomore), and including the period beginning with the second semester of 1909–10 and ending with the first semester of 1912–13, one teacher is credited with 10 per cent of *E*'s, the next highest percentage being 6, which is reported by three teachers. This is quite a decided drop from 55 per cent which was shown under the old system. A single teacher reported no *E*'s for the under courses. It is interesting to note that the average percentage of *E*'s for these courses is 3.38, which seems quite reasonable. Compared with the suggested probable total of *E*'s and *S*'s of 25 per cent, experience has given 22.29 per cent, the great variations being one of 34 per cent, one of 30 per cent, one of 12 per cent, and one of 13 per cent. For the *M* grades the average is 52.49 against the 50 per cent suggested, with the great variations of one of 70 per cent, one of 64 per cent, one of 35 per cent, and one of 38 per cent. The average total of *I*'s and *F*'s is 25.22 against 25 per cent, the greatest variations being one of 44 per cent, one of 41 per cent, two of 12 per cent, and one of 14 per cent. The system requires that the minority of the lowest 25 per cent shall be marked *F*, and the report for under courses places the figures for this grade of students at 7.32 per cent.

For upper (junior and senior) and professional courses the figures differ slightly, the comparison with the under courses being shown in the table below. Among the sixty-four teachers represented in the upper and professional courses, four are high markers with 18, 14, 13, and 10 per cent of *E*'s, but even these are considerably below the 55 per cent of the old system. There are also two low graders with 19 and 11 per cent respectively charged against them.

It should be stated that in the report for under courses, no teacher with fewer than 500 grade-hours, and in the report for the upper and professional courses, no teacher with fewer than 250 grade-hours is included.

COMPARATIVE PERCENTAGES.

	E	*S*	*M*	*I*	*F*
Under courses	3.38	18.91	52.49	17.90	7.32
Upper and professional courses	4.73	22.84	53.49	15.13	3.81

Many teachers, perhaps the majority, believe that courses should be adapted to the average students in the various classes. This permits the better students to prepare their lessons in a comparatively short time and enables them to do wider reading in the particular subject or to engage in other broadening work, and at the same time allows the inferior students to get something out of the course.

Some of the low markers attempt to explain their percentages by saying that their students are insufficiently prepared, but many educators will agree with Dr. Meyer in his assertion that these teachers are usurping rights which are not justly theirs, and that the proper authorities should readjust the entrance requirements when it has been clearly demonstrated that such change is necessary.

Some of the high markers argue that they are extremely particular about admitting students to their classes, but it would seem that it would require a very large number of exclusions to account for the difference between 4.73 and 18 per cent, and it is doubtful if a teacher is warranted in pre-

judging and excluding on meager evidence students who might get considerable value out of his courses.

Proper Number of Grades.

As to the most desirable number of grades to assign, some teachers are satisfied with two; *passed* and *not passed*. Some institutions, such as the University of Kansas, use three; Harvard University and many others use five; and Reed College, after a careful study of the subject of grading by President Foster, decided on ten.

To minimize friction and increase efficiency the number of working parts of a machine should be kept as low as possible. Many will agree with Professor Winslow H. Herschel that the odd number of grades is preferable. Most teachers will concur in the belief that approximately 50 per cent of any large number of students are of *average* ability, and that the balance is about evenly divided between those *above the average* and those *below the average*. But three divisions are hardly sufficient for the purpose of awarding prizes and honors. A very small number of students possess exceptional ability and work up to their capacity, and a few are mentally deficient or lazy, or both. To provide for these it would seem that five grades are sufficient for the majority of educational institutions.

Subjective and Objective Grading.

Teachers should keep in mind that they are grading for ability, and ability as demonstrated by performance rather than ability as determined from general impressions. Tests should be of such a character as to enable the teacher to draw correct conclusions with the least possible amount of fatiguing labor. Some teachers have been known to shirk the reading of long and numerous examination papers, and to rely almost entirely on general impressions. This is of course manifestly unfair to the students who should have the right to feel that they are being graded for their ability as evidenced by their performance.

In mathematical and engineering courses subjective and

objective valuations may be combined. In such subjects as experimental and educational psychology, chemistry, and zoology the Ebbinghaus method of conjectural examination has been found to check with other methods, and to give effective results with much less labor on the part of the teacher. Professor Karapetoff has expressed himself as well pleased with this method as used in his classes in electrical engineering at Cornell University.

Perhaps the simplest and best way to arrive at conclusions in using the grading system as adopted at the University of Missouri is to rank the students (using the numbers 1, 2, 3, 4, 5, . . .) for each test, quizz, or examination. If it is desired to give any special weight to any particular test, the rank numbers for that test may be multiplied by the proper coeffi-

FINALS FOR CLASS OF TWENTY-FOUR.

Name	Recitations	Quizzes	Reports	Examination	Totals	Diff.	Grade	P. C.
H	1	1	2	3 (1)	7		*E*	4.17
J	4	6	4	9 (3)	23	16	*S*	
I	3	2	6	12 (4)	23	0	*S*	
O	2	8	7	6 (2)	23	0	*S*	16.66
F	5	4	1	15 (5)	25	2	*S*	
N	5	3	3	24 (8)	35	10	*M*	
A	8	5	5	21 (7)	39	4	*M*	
V	7	10	12	18 (6)	47	8	*M*	
G	10	17	8	30 (10)	55	8	*M*	
B	13	14	9	27 (9)	63	8	*M*	
M	9	11	11	36 (12)	67	4	*M*	
E	12	11	17	33 (11)	73	6	*M*	54.17
T	18	9	14	39 (13)	80	7	*M*	
W	11	16	10	54 (18)	91	11	*M*	
C	15	18	18	42 (14)	93	2	*M*	
X	14	15	22	48 (16)	99	6	*M*	
P	16	13	16	57 (19)	102	3	*M*	
D	21	19	15	51 (17)	106	4	*M*	
L	24	23	24	45 (15)	116	10	*I*	
R	20	17	20	60 (20)	117	1	*I*	
U	19	20	13	66 (22)	118	1	*I*	20.83
Q	17	24	22	63 (21)	126	8	*I*	
K	22	18	20	66 (22)	126	0	*I*	
S	22	21	21	72 (24)	136	10	*F*	4.17

cient, as shown below where examination rank numbers have been multiplied by three, thereby giving equal weight to examination and term work. To ascertain final grades summations of the rank numbers for the several students may be made and these summations may be arranged in order according to size. By keeping the prescribed percentages in mind and observing the differences in summations, the finals may quickly be derived.

Conclusions.

The various studies which have been made show that, when a sufficiently large number of grades in any institution is considered and the values are tabulated, the resulting curve approximates the curve of probability. It merely remains then to convince those teachers whose marks deviate greatly from the average marks of all other teachers in the institution that they should make an effort to ascertain the reason for such deviations, and if they are unable to discern and remove the cause, or if they are unable to account for their differences, they should be required to submit their rankings for their various tests to the chairman or head of the department for the assignment of the grades.

The system in use at the University of Missouri was adopted for the purpose of bringing about greater uniformity in the grading of the students. There has been a decided advance toward the desired end. There are a few straggling deviations corresponding to what are known among scientific observers as huge errors, and in judging the system we may emulate scientific computers in rejecting these as due to incorrect conclusions or to extraordinary coincidences.

Any system must be used with sound judgment, without fear or favor, and it is believed that this system so used is the best that has thus far been devised for the equitable grading of students for ability and performance.

In closing it may be pardonable to quote: "The most perfect system of rules to insure success must be interpreted upon the broad grounds of professional intelligence and common sense."

BIBLIOGRAPHY.

"Examinations, Grades, and Credits," by Professor J. McKeen Cattell: *Popular Science Monthly,* Feb., 1905, p. 367.

"A Guide to the Equitable Grading of Students," by Professor Winfield Scott Hall: *School Science and Mathematics,* Vol. 6, 1906, p. 501.

"The Grading of Students," by Professor Max Meyer: *Science,* Aug. 21, 1908, p. 243.

"School and University Grades," by Professor Walter Fenno Dearborn: *Bulletin of the University of Wisconsin,* 1910, No. 368: High School Series N. 9.

"Scientific versus Personal Distribution of College Grades," by President William T. Foster: *Popular Science Monthly,* April, 1911, p. 388.

"Experiences with the Grading System of the University of Missouri," by Professor Max Meyer: *Science,* April 28, 1911, p. 661.

"The Ebbinghaus Method of Conjectural Examination," by Dr. A. P. Weiss: *Journal of Experimental Pedagogy,* June 5, 1912, p. 320.

"Scientific Distribution of Grades at Reed College," by President William T. Foster: *Science,* June 7, 1912, p. 887.

"School Grades—To What Type of Distribution Shall They Conform?" by Dr. A. P. Weiss: *Science,* Sep. 27, 1912, p. 403.

"Scientific Ranking Systems," by Professor Winslow H. Herschel: *Bulletin of the Society for the Promotion of Engineering Education,* Apr., 1913, p. 529.

DISCUSSION.

Professor E. F. Chandler: Attention should be called to the difficulty of imposing uniformity in a marking system on members of a faculty. We have had some experience of this at the University of North Dakota during the past ten years. We tried, for a time, to give surplus credit for high standing,

but have now discarded the plan. The difficulty in using it is this; that certain students will pass or fail under any system. The amount of work expected of them is also fairly well determined or standardized. However, among those that pass there is a marked distinction between those of high and those of low standing; this distinction has not been reduced to standard terms. Unless considerable pressure is brought to bear upon them to see that there is reasonable uniformity among departments some teachers will give a disproportionate number of high standings. This practice attracts a certain sort of students into these courses, partly to secure the credits, although this tendency is perhaps an unconscious one. On the other hand some teachers are proverbially low markers. While they will pass a reasonably large proportion of their students they give them excessively low marks. Theoretically I approve the principle of giving excellent students surplus credit for good work. This principle is pedagogically correct. An *"A"* student is worth twice as much as one who barely passes, so that the Missouri system, if it can be operated properly, embodies correct principles. The chief difficulty that we found was in securing operation equitable between different students and different departments.

Dean C. M. Woodward: This discussion reminds me of one of our professors whose assistant came to him stating that he had a class in modern language and that as there was not a poor student in the class he wished to pass them all. The professor replied, "You must never do it. Condition at least twenty per cent of them. I know nothing about the class, but I am sure that percentage should not pass." You see, gentlemen, the professor had some kind of a curve in mind and the students were virtually all marked beforehand. That, in my opinion, is the danger of marking by a curve.

Professor E. R. Hedrick: In answer to a suggestion that there might be difficulties in carrying out a scheme of so mechanical a nature, I would say that no practical difficulties have arisen at the University of Missouri, except in the case of a few men who have interpreted the rule at times very

literally, and have read into it specifications that it does not contain. Thus I know of one case in which an instructor informed his class that he was obliged to give some member of the class an *"F"* grade, no matter how perfectly the work of the class was done. Such an attitude is of course indefensible and is, fortunately, rare. If the rules are tempered with a certain admixture of common sense, as they usually have been, no difficulty of the nature suggested need arise. In practice, the plan works well; and the number of cases of unwise grading at least compares very favorably with our experience before the rule was adopted.

Professor Hyde: Some time after the practice of giving excess and reduced credits was adopted at the University of Missouri fear was expressed by a few teachers that the better students in arts would take advantage of their opportunities and leave the university to engage in attractive profitable employment or to do advanced work at other institutions. An investigation revealed that not a single student had been graduated in three years, and that only about 6 per cent were able to complete the requirements in seven semesters.

In engineering the greater part of the work is prescribed, from 12 to 15 hours only being elective. To these electives students may apply their excess credits if they so desire, but in general it may be said that the better students usually carry a full complement of work.

It is impossible to prevent some teachers from misinterpreting any rule or system of rules. One insisted that the system was absolutely rigid and that students might conspire to lower the quality of the work or reduce the amount of ground covered and the prescribed percentages would still have to be assigned. That the contention is absurd goes without saying. A teacher may "fail" a whole class under this system or any other system, if the circumstances warrant.

In connection with the system at Missouri a committee on statistics issues two reports as soon after the completion of each semester's work as possible. One of these is issued in confidence to teachers only showing how each teacher has

graded his students and permitting him to compare his own record with that of each of the other teachers as well as with the prescribed average.

The other report shows the standing of various groups of students, such as Under Courses (Freshmen and Sophomore, Arts), Upper (Juniors and Seniors, Arts) and Professional Courses, Total of All Courses, Men, Women, Professional Fraternities, Freshmen-Arts, Freshmen-Agriculture, Sophomore-Arts, Sophomore-Agriculture, Class Football, Varsity Football, Freshman Basketball, Varsity Basketball, Non-Athletes, Social Fraternities, Non-fraternity Men, excluding Freshmen, Social Sororities, Non-sorority Women, excluding Freshmen, Individual Fraternities, Individual Sororities, Individual Professional Fraternities.

It is believed that the publicity in both cases is very beneficial.

HYDRAULIC ENGINEERING EDUCATION.

BY DANIEL W. MEAD,

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The Aim of Engineering Education.

All who have given much thought to the subject of education will agree with me that the purpose of education is not so much to impart knowledge as to train the student to acquire knowledge. The purpose of technical education, therefore, is not so much to impart technical knowledge to the student as to furnish the training which will enable him to understand and investigate the conditions which surround a problem, to determine the fundamental principles on which its successful solution depends, to ascertain and analyze the elements which influence or modify it, to design the structures and works needed for its successful development, and to supervise the proper construction of such structures or works and carry them to a consummation of successful and economical completion. This, in my judgment, is the essential aim of engineering education.

Requisites in an Engineer.

The engineer must have a comprehensive understanding of the elements that underlie his problem and on which its proper solution depends. He must know what and how to investigate, and how to analyze and weigh the influence of every factor involved. He must be able to see or determine the value and effect of each element in the problem, and he must know where the knowledge needed for these ends is available and how to acquire it. He must understand ways and means as affecting both construction and operation, and, so far as possible, he must have developed his judgment, sense of justice and equity, and common sense.

The Content of a Technical Course.

The amount of knowledge that can be retained in the mind at any one time is exceedingly limited, and in discussing education it must be understood that the time spent in the university course as well as the mental capacity of the student are both too limited for the acquisition of anything more than the elements of knowledge needed by the practicing engineer.

For the purpose of technical education, instruction is required in the following:

1. In the fundamental principles of those sciences on which the practice of the engineer necessarily depends.

2. In those methods and calculations which must be applied in such practice.

3. There should be included to as great a degree as possible instruction in those human elements that concern the personal relationship of the engineer with his fellows, with his clients, with contractors, and with the public, and also those matters of judgment, equity and ethics upon which the highest success of the engineer depends no less than upon his technical knowledge.

Judgment.

Judgment can be developed by experience only, but the tendency of technical education is rather to the detriment of judgment. If text-books and instructors are considered infallible, if their lectures and dicta are to be taken without question, the development of judgment is certainly not stimulated. An earnest effort should be made to point out the limits of theory and the point where judgment and speculation begin. The use and abuse of formulas should be noted, and their limitations pointed out and emphasized. Every experienced engineer recognizes the convenience of formulas but also understands the danger of their careless application. I know no better way of encouraging judgment or emphasizing the limitations of formulas than by a careful and detailed study of actual professional problems where the uncertainties are clearly pointed out. I have had a great many young men

in my employ in private practice and have found that in a great many cases they were largely dependent upon formulas with which they had become familiar in their college course, often assuming them to be absolutely dependable when frequently they were not applicable to the particular cases at hand. Again, in many cases, if the formulas were not available, the work at hand was attacked with great difficulty.

Ethical Principles.

One of the most important factors of technical education in every line is the ethical attitude which is necessary for engineering success. This can not well be taken up as a special study, but should be introduced by instructors whenever the time seems appropriate.

Most practicing engineers recognize the fact that a true view of ethical relations is fully as important as technical knowledge, and no student should leave his university without being impressed with the more important ethical principles. One of the most important of these is a knowledge of self-limitation, and an appreciation of the fact that success is mainly due to hard work and not to great brilliancy. The student must be brought to appreciate his own limitations and the meagerness of his knowledge, and must learn that success in any line is dependent on thorough, hard, conscientious and intelligent work. Most so-called men of genius have accomplished results by constant and unremitting application, by untiring drudgery, rather than by great brilliancy; and all that is most worth while in life is accomplished or secured in the same manner. Opportunity is undoubtedly important, but hard work usually creates opportunity, and no man accomplishes true success without these elements ingrained in his character.

Another characteristic of success is dependability. No amount of knowledge or work can take the place of this attribute. The man who can be depended upon is ever in demand and if he has also acquired a high degree of technical training and an appetite for hard work, his success, barring accidents, is assured.

The teaching of such principles is difficult but essential, and should be introduced in the technical course with professional subjects. It can, I believe, come best from those instructors of more mature years who are most closely in touch with practice.

While the average student objects to "preaching," I find that no other subjects so intensely interest a class of advanced students as those which have to do with the relationship of the engineer to life and to the ethics of professional practice.

Breadth of Education Desirable.

All knowledge is more or less related, and every subject bears more or less directly on every other subject. It has been said that if any man knows all that can be known of any one subject he knows all that there is to be known of every other subject. Such a comprehensive knowledge is of course ideal and impossible of realization, but a broad foundation of many subjects is necessary to a true appreciation of any one. This is especially true of technical knowledge; and for a broad knowledge of any specialty it is both desirable and necessary that the student have a general knowledge at least of other specialties.

Danger of Extreme Specialization.

There is, perhaps, no more narrow man than the specialist who knows nothing of aught but his specialty; he is an unsafe guide except along his own narrow lines, for when his lines cross or run parallel with other subjects, he has no true perspective of relative importance or of relative values.

It has been said that if you are sick and go to a tailor, his prescription will be a new suit of clothes. Every thoughtful engineer will realize that his personal experience and bias will influence his recommendation. Recently a proposition was under consideration that involved the installation of two pumping engines of six million gallons capacity in a location where it was undesirable to construct a boiler plant and where in consequence power had to be transmitted in one form or

another for about a quarter of a mile. Various electrical engineers who were brought into the discussion uniformly recommended the use of electrical generation and transmission. A large steam-electric installation was already available in the main plant, and the electrical engineers advised the use of that plant which, however, was about four times too large. When it was pointed out that the efficiency would be very low on account of the large size of the generating plant, the electrical engineers advised the installation of a steam-electric plant of proper size for the work to be done. After due consideration of the proposition, steam transmission, the steam pipes being carefully insulated, was installed. The steam consumption of the plant actually installed was about half of what it would have been with a special electrical plant designed for the service, and about one-quarter of what it would have been with the large plant that was already installed; and at half and quarter loads, at which points the plant operated a considerable portion of the time, the saving was very much greater. The error in the advice of the electrical engineers is therefore obvious. The tendency of the specialist is always to advise the application of his specialty.

I believe that one of the most important elements in the instruction of the young engineer is to lead him to appreciate not only his own specialty but to give him a correct appreciation of the specialties of others. The engineer who is educated in only one specialty and has not the knowledge necessary to compare it with others, is poorly prepared for professional life, and his training will not give the best results to either himself or his clients.

Specialization is, in my opinion, a serious mistake if carried far in a university course if the desire is to educate engineers instead of training skilled workmen. The ideal university for the education of the engineer is not a trade school. The education should be largely general, and special branches should be so handled as to broaden and not to narrow the student; they should be considered with relation to other lines with which they may have to be compared.

Engineering Courses Fairly Satisfactory.

In most branches of engineering, the courses of our engineering schools are fairly satisfactory. The principles and methods on which investigations and practice must rest are fairly well covered, and the young engineer when he leaves his technical school is fairly well prepared to undertake the minor calculations and designs in the practice of his profession. He still needs experience, postgraduate study and investigation, which are necessary for more advanced work and can be obtained to the best advantage concomitant with the practice of his profession.

The Weakness in Hydraulic Engineering Education.

In the teaching of hydraulic engineering there is a decided weakness in the professional courses pursued in most schools. The great loss of life and property in recent floods; the similar losses caused by the failures of dams and reservoirs within recent year, and the errors in estimating hydraulic resources, resulting in the partial or complete financial failure of many hydraulic projects in irrigation, water power and water supply, point to the great need of fundamental education along hydrological lines both of the people as a whole and of engineers on whose shoulders more particularly rests the responsibility for the success of these various projects.

Since the recent disastrous floods, the lack of exact information has become especially apparent. A great deal of so-called knowledge concerning hydraulic and hydrological matters is simply speculation, or may even be classed as fable and superstition, which even a little investigation would show to be erroneous. As examples of these errors into which both business men and engineers are frequently involved, numerous instances might be cited. Mr. James J. Hill, in an article in one of the recent magazines, points out that the building of levees along the Mississippi River is a failure because the river is gradually building up its bed almost as fast as the levees are constructed. Now it is a fact which has been demonstrated by some 400,000 soundings by the Mississippi River Com-

mission, that the Mississippi River is not building up its bed, and the proposition laid down as an axiom by Mr. Hill is entirely in error. Another popular fallacy is the universal adaptability of reservoirs to prevent floods, that reservoirs furnish the solution of flood prevention. In a recent paper by Colonel Townsend, president of the Mississippi River Commission, delivered at the Drainage Congress in St. Louis, he made the following statement, which can be readily verified. Taking into account the length of time in which the water would reach Cairo from Pittsburgh, St. Paul and St. Joseph, even if at that time reservoirs had been available with capacity sufficient to have cut off the flow of the Mississippi above St. Paul, of the Monongahela and the Allegheny above Pittsburgh and of the Missouri above St. Joseph, the height of the water at Cairo would have been reduced but six inches. I know of no better illustration of the limitations of reservoirs as a universal panacea for floods.

Not long ago I received a letter from the editor of an engineering magazine calling attention to the control of the Chagres River by the Gatun Dam, saying he hoped that all engineers would unite in the recommendation to apply this same principle to the control of the Mississippi River. Could any proposition be more absurd? Even a layman should realize that physical conditions must control, and that no scheme of flood control is universally or even generally adaptable.

The popular clamor for waterways as a sure cure for commercial and transportation difficulties, regardless of detailed consideration and investigation, and the theory of the universal influence of forests in conserving, equalizing and improving the flow of streams, are examples of erroneous hydrological ideas that will not bear the test of careful and thoughtful investigation. These subjects should be so considered and discussed in a hydraulic engineering course that the future hydraulic engineer will realize the necessity for careful investigation and the determination of the actual value and influence of a given structure or plan of development on the

betterments desired, and not be misled by popular clamor and irrational assumptions.

Necessity for Hydrological Education.

Experience in the field has demonstrated the fact that more failures have resulted in various projects of hydraulic engineering from a lack of an adequate conception, on the part of the designing engineer, of the fundamental principles of hydrology and of the importance of hydrological factors, than from defects in the design or construction of the various structures involved. In many cases the engineer has not possessed sufficient knowledge to appreciate the necessity for hydrological investigation and study, and very frequently has ignorantly made unwarranted assumptions and neglected any investigation whatsoever, because of the lack of such appreciation.

As a result of this lack of appreciation of the fundamental basis on which every sound hydraulic project must rest, we find numerous irrigation projects completed at large expense but without adequate water supply; water power plants constructed on streams not having sufficient available flow, or with such irregular flows as to make the projects entire or practical failures; spillways and gates in dams constructed with inadequate capacities for the passage of extreme floods; pumping stations constructed to utilize supplies of water which are too limited for the purposes for which they were intended, or with supplies polluted, or otherwise undesirable; communities and industries located in situations where they are subject to serious overflow and unnecessary flood damage; protecting works built with no adequate idea of the maximum necessities of the case, or their effect on flood heights; drainage enterprises undertaken with no adequate knowledge of the flood capacities which must necessarily be provided for extreme conditions. In many ways unnecessary losses are frequently entailed which have been due largely to the fact that the attention of hydraulic engineers has not been called to the importance of hydrological information, the sources from

which such information can be obtained, or the necessity and methods of undertaking hydrological investigation and study.

Necessary Limitations of Technical Instruction.

The subjects considered essential in technical education are so numerous that it is very evident that scarcely more than the barest outline of any technical subject can be acquired within the necessary limits of a university course. It is, of course, manifest that in the brief time available for professional studies in technical schools the lines of instruction must be more or less limited, and that a full consideration of any professional subject must be left for the investigation and study of the young engineer after he has begun actual practice of his profession. No professional study can be attempted except in a most elementary and incomplete manner; but in every case the student should receive instructions as to what to study, and how to investigate in his own special line of professional practice.

For example, the subject of water supply, which is treated in one semester in most universities, usually occupies the time of the student about one hundred and fifty hours, or the equivalent of fifteen or twenty days. During this limited time, instruction must be given in the entire subject of water supply, including the sources of supply, development of underground and surface waters, distribution systems, standpipes, reservoirs, pumping machinery, and numerous other subjects. Any practicing engineer will spend usually more time than can be given to this entire subject on a single phase of a single proposition which may come before him. It is therefore obvious that such a course can cover only briefly the most important points, and that the student when he leaves his university knows nothing about the comprehensive subject of water supplies except how to investigate and study the subject. To instruct the student in methods of investigation and study is the only attempt that can reasonably be made in the teaching of any professional subject such as water supply, water power, irrigation, drainage, etc. This is the object of such a university course.

THE CONFIRMATION OF TECHNICAL INSTRUCTION.

Technical knowledge to be of the greatest value must be confirmed by practice. Even the fundamental principles acquired by the student become truly his only after they have been demonstrated under many conditions and in many places. When the statement of the teacher and of the text has been fully investigated and verified, then and only then is the knowledge truly acquired. It must, therefore, be understood that university work to be of real value must be supplemented by study, observation, practice and experience.

The deficiencies in hydrological training are well illustrated by the following example. I had occasion only a few years ago to examine an irrigation project in the arid west that had been laid out by a graduate of one of our engineering institutions. The design, so far as the structural features were concerned, seemed to be excellent. When the question of water supply was discussed, the engineer in charge stated, "Oh, there is plenty of water, there is no question about that; I have been around that stream for several months, and I know there is always plenty of water." Later, when the matter was examined in detail, it was found that there was not over one third to one fifth of the water that would be required, and the engineer finally remarked, "Well, to be honest, I did not know how to make an estimate of the water supply or how to investigate it."

On this same project, an older and more experienced practicing engineer, who was in charge of a similar project costing over three million dollars, visited the same work, and a rainstorm occurred at the time so heavy that the gullies were running full and he had to wait several hours before making some small creek crossings. From his chance experience, under most unusual conditions, he said, "Gentlemen, you have water enough to irrigate this whole valley." An investigation of the water supply showed so little water that the project was rejected as impracticable.

I have seen so many errors of this kind in my examination of projects in the various lines of hydraulic engineering that

I believe engineering schools should give some attention to this subject. I do not wish to imply that a great amount of time is necessary, but rather to express a belief that the attention of the student should be drawn to these important hydrological subjects and that some systematic course of limited extent should be arranged to point out the dangers in hydraulic projects of ill-advised plans based on inadequate knowledge. The source and necessity of such knowledge should be made plain to the student, so that when the time comes he will know what his problem is and how to study it.

The teacher cannot expect to impart to the student the knowledge that can be assimilated only by long years of experience. Even the engineer in practice can keep in mind only those things with which he is in daily contact: he must look the others up; he must study them; he must acquire and reacquire them as he needs them.

Educational ideals are by no means fixed; they must grow and develop; they must change with the times and the circumstances. In my judgment, most engineering courses can be greatly improved by a judicious introduction of the personal and ethical factors. In hydraulic engineering courses much more attention should be given to fundamental principles which have in general been too long neglected.

The ordinary engineering course provides fairly complete instruction in mathematics, strength of materials, design of structures, and in the calculation of problems connected with those physical phenomena on which the practical success of engineering structures must depend. The whole training of the engineer emphasizes the necessity of a knowledge of the principles of design in order to give adequate strength and stability to the structures to be designed and installed. While errors in such designs are only too abundant, they are, in hydraulic-engineering projects, much more limited than the more fundamental errors that are due purely to the lack of appreciation of the very element of the problem on which success most depends.

No engineer would attempt to design the physical structures

of a water-works system or water-power plant without endeavoring to acquaint himself with the principles and practices on which the successful construction of such structures must depend; and yet, the water supplies on which the success of these projects is entirely dependent are frequently only superficially investigated, or the sufficiency of supply assumed. It would, therefore, seem illogical that our schools should provide instruction in these technical subjects which can readily be taken up by the engineer in post-graduate study, either in college or out, and fail to provide a thorough course in the fundamental underlying principles of hydrology on which the success of all such projects *must* largely depend.

A certain amount of professional study in a technical school is undoubtedly desirable inasmuch as such study permits instruction in the methods of investigation and design, and points out the application of the previous theoretical work of the student. It seems illogical, however, that such professional study should be pursued to an extent which will cause the neglect of a line of instruction so important to the ultimate success of the hydraulic engineer.

Hydrology.

Hydrology should treat of the laws of the existence and distribution of water over the earth's surface and within the geological strata, and of its sanitary, agricultural and commercial relation. It should discuss hydro-meteorology principally in relation to the occurrence, distribution, variation and disposal of rainfall and the run-off resulting therefrom, in drought and in flood. It should discuss the modifications of the run-off caused by evaporation, topography, geology, temperature, and various other factors, and the variation in run-off as the factors vary in importance. The great variations in the unit run-off under similar rainfall conditions but different physical conditions, and under similar physical conditions but different rainfall conditions, should be studied, and the marked differences which arise in different parts of the

country depending on these differences in conditions should be discussed and appreciated. The effects of storage, of cultivation, of forestation, and of other artificial physical modifications of the drainage area on the flow of streams should also be discussed.

The study should include hydro-geology, or the occurrence of water in the strata, and the laws of its occurrence and flow. This must presuppose or include a sufficient study of general geology to give a comprehension of the geographical limitations which must be expected in hydrographic conditions, and the modifications due to geological changes. Water as a geological agent should be discussed, and through such discussion and study a comprehension of the birth, the growth, and the development of drainage systems and of rivers attained. The apparent lawless and erratic action of streams will be thus found to follow laws more or less distinct and which must be studied and comprehended before intelligent river conservation becomes possible.

The rainfall and other accompanying phenomena are proverbially inconsistent; and yet the study of hydrology shows that there are limitations to such inconsistencies, which limitations are quite as narrow and exact as those that arise in other engineering fields which must be cared for by the "factor of safety," which is simply a "factor of inconsistency" in the qualities or occurrences of conditions with which the engineer always has to deal.

In the studies of water supply and storage which are offered in most engineering schools, various hydrological subjects are briefly discussed. In the study of geology and meteorology, which studies are sometimes included in the engineering courses, some of these subjects are also treated. Too often, however, mere facts and figures are presented concerning various phenomena, but such facts and figures are seldom correlated and the attempt is seldom made to establish relationships from which conclusions can be drawn and on the intelligent use of which the success of hydraulic work must depend.

In no work on the subject of irrigation, with which I am familiar, is the relation of rainfall to run-off, or the value and limitations of comparative hydrography, discussed even in a limited way, nor is any method of investigation pointed out.

In very few instances is the subject of hydrology systematically taught in a manner sufficiently complete to afford a reasonable basis for the investigation and study necessary to the successful practice of the hydraulic engineer, or even to a sufficient extent to give the engineer a reasonable appreciation of the importance and necessity of such study and investigation. In many cases the student enters professional life with no appreciation of this subject, and with no knowledge of the availability of the great fund of hydrological information which has been accumulated at the expense of much time and labor, and as a result of the success and the failure of many hydraulic projects. Surely our engineering schools should add this important subject of hydrology to their curricula.